DEFENCE R&D DÉFENSE

New Technology Applications for Military Logistics

Dr. Abe Jesion

Defence R&D Canada

TECHNICAL MEMORANDUM
DRDC TM 2002-002
March 2002

National Defence Défense nationale

Canada

104-05615/

New Technology Applications for Military Logistics

Dr. Abe Jesion
Directorate of Science and Technology Policy

Defence R&D Canada

Technical Memorandum
DRDC TM 2002-002
March, 2002

Author

Dr. Abe Jesion
Defence Scientist

Approved by

Dr. Ingar Moen
Director Science and Technology Policy

Approved for release by

Dr. Ingar Moen
Chair, Document Review Panel

© Her Majesty the Queen as represented by the Minister of National Defence, 2002
© Sa majesté la reine, représentée par le ministre de la Défense nationale, 2002

Abstract

This paper is a preliminary examination of the relationship between various new technologies and modern military logistics. A brief overview of Canadian military logistics is given together with a list of important factors such as defence policy and geography that play a significant role in logistics planning. Making use of the framework developed for the Defence Research and Development Canada (DRDC) Technology Investment Strategy (TIS), a number of leading-edge technologies are listed and their potential relationships with military logistics are highlighted. Finally, a short discussion of the opportunities and risks contained in these relationships is presented.

Résumé

Ce document présente un examen préliminaire des rapports entre diverses nouvelles technologies et la logistique militaire moderne. Un aperçu général de la logistique militaire canadienne est accompagné d'une liste de facteurs importants dans la planification logistique, tels que la politique de défense et la géographie. Dans le cadre de la Stratégie d'investissement technologique de Recherche et développement pour la défense Canada (RDDC), un certain nombre de produits à la fine pointe de la technologie sont présentés ainsi que leurs éventuels rapports avec la logistique militaire. Pour terminer, une courte discussion porte sur les possibilités et les risques pouvant découler de ces rapports.

This page intentionally left blank.

Executive Summary

Defence policy commits the Canadian Forces (CF) to the generation, employment and sustainment of high-quality, combat capable, inter-operable and rapidly deployable task-tailored forces. To accomplish this goal, military planners must develop and extend their logistics capabilities to meet such challenges as supply chain management, material acquisition and support, long distance transportation, personnel services, facilities and equipment maintenance, etc. in both traditional and non-traditional operational environments. These challenges must be addressed in the context of geo-political, economic and demographic realities that affect Canadian interests both domestically and internationally.

Defence Research and Development Canada published a Technology Investment Strategy (TIS) to ensure that the CF of the future remains technologically prepared and relevant. It was developed in response to the projected set of new capabilities that the CF will need in 2010 and beyond. A number of Research and Development (R&D) Activities that are described in the TIS have direct and indirect applications to logistics support for military operations. One example is the application of "Information and Knowledge Management" R&D to improve the automation of business processes such as supply chain management. Another example is the application of "Emerging Materials and Biotechnology" R&D to develop high performance materials and power sources for improved sustainment.

The application of new technology to military logistics is not without risk. Dependence on certain types of weapons, sensors, materials, platforms, information systems, etc. may increase costs, heighten logistics vulnerability to asymmetric threats and increase personnel fatigue. Care must be taken to invest in promising technologies that limit such risks to "acceptable levels".

The following recommendations are made:

a. CF logistics planners should become more familiar with the R&D activities and expertise within DRDC and DRDC staff should in turn become more familiar with CF logistics R&D requirements;
b. Clients for logistics technology R&D and DRDC managers should establish a more formal relationship to plan and execute R&D in the Canadian military logistics domain; and
c. Technologies that are not currently in the DRDC TIS but that have value to the military logistics community should be identified. As well, the means to acquire such technologies should be identified.

Jesion, A. 2002 New Technology Applications for Military Logistics. DRDC TM 2002-002. Directorate of Science and Technology Policy, Defence R&D Canada.

Sommaire

En vertu de la politique de Défense, les Forces canadiennes (FC) doivent mettre sur pied, utiliser et soutenir des forces aptes au combat, interopérables, déployables rapidement et adaptées à la tâche. Pour atteindre ce but, les spécialistes en planification militaire doivent développer et adapter leurs capacités logistiques en vue de relever des défis comme la gestion de la chaîne d'approvisionnement, l'acquisition et le soutien du matériel, le transport de longue distance, les services du personnel, l'entretien des installations et de l'équipement, etc., dans des milieux opérationnels traditionnels et non traditionnels. Ces défis doivent être traités en fonction des réalités géopolitiques, économiques et démographiques qui touchent les intérêts canadiens au pays et à l'échelle internationale.

Recherche et développement pour la défense Canada a publié une Stratégie d'investissement technologique (SIT) afin de garantir que les FC de l'avenir seront prêtes et bien adaptées du point de vue de la technologie. Ce document a été créé en raison des nouvelles capacités dont les FC devraient avoir besoin en 2010 et dans les années qui suivront. Un certain nombre d'activités de recherche et développement (R et D) décrites dans la SIT peuvent être appliquées directement et indirectement au soutien logistique des opérations militaires. Par exemple, l'application de la R et D pour la « Gestion de l'information et du savoir » en vue d'améliorer l'automatisation des processus administratifs comme la gestion de la chaîne d'approvisionnement. Un autre exemple : l'application de la R et D concernant les « Matériaux nouveaux et la biotechnologie » afin de développer des matériaux et des sources d'énergie à haut rendement qui permettront d'améliorer le maintien de puissance.

Or, l'application de la nouvelle technologie à la logistique militaire n'est pas sans risque. L'assujettissement à certains types d'armes, de capteurs, de matériaux, de plates-formes, de systèmes d'information, etc., pourrait faire augmenter les coûts, accentuer la vulnérabilité logistique aux menaces asymétriques et aggraver la fatigue du personnel. Il faut donc s'assurer d'investir dans des technologies prometteuses qui limitent de tels risques à des « niveaux acceptables ».

Voici les recommandations formulées :

a. les spécialistes de la planification logistique des FC doivent se familiariser avec les activités de R et D et l'expertise au sein de RDDC, et le personnel de RDDC doit apprendre à connaître les besoins en matière de R et D logistique des FC;
b. les clients de la R et D en matière de technologie logistique et les gestionnaires de RDDC doivent établir une relation plus officielle en vue de planifier et d'exécuter la R et D dans le domaine de la logistique militaire;
c. il faut cerner les technologies qui ne font pas partie de la SIT RDDC, mais qui pourraient être utiles à la collectivité de la logistique militaire, ainsi que les moyens d'acquérir de telles technologies.

Jesion, A. 2002. New Technology Applications for Military Logistics. DRDC TM 2002-002. Directorate of Science and Technology Policy, Defence R&D Canada.

Table of Contents

Abstract i

Résumé i

Executive Summary iii

Sommaire iv

Table of Contents v

Background 1

Defence Policy 1

Military Logistics 2

Aim 3

Scope 3

The Context for Military Logistics 4

Defence Strategy 4

Planning Levels 4

Logistics "Sub-Systems" 5

Canadian Joint Task List 5

Geo-political Context for Logistics Planning 6

Economic Context 7

Demographic Factors 8

Relationship Between Technologies and Logistics 9

The Technology Investment Strategy 9

Technology Opportunities 10

DRDC R&D Activities 11

The Revolution in Military Affairs 12

Supply Chain Management 12

Transportation (Personnel and Material Movement) 13

Personnel Support Services 13
Maintenance and Engineering 14

Discussion **15**
New Technologies 15
Risks 15
Human Resource (HR) Issues 16
Cost Issues 16
Observations 16
Recommendations 17

Concluding Remarks **18**

References **19**

List of Abbreviations **20**

Background

Defence Policy

Military operations are becoming more challenging and complex as a result of new threats and demands being made on the Canadian Forces (CF) and the Department of National Defence (DND). Policy direction such as that contained in the 1994 Defence White Paper states that Canada requires multi-purpose forces for a wide spectrum of possible operations for the foreseeable future. Furthermore, the White Paper ties both new technology and logistics to defence requirements:

> "The Defence Team will generate, employ and sustain high-quality, combat-capable, inter-operable and rapidly deployable task-tailored forces. We will exploit leading-edge doctrine and technologies to accomplish our domestic and international roles in the battlespace of the 21st century and be recognized, both at home and abroad, as an innovative, relevant, knowledge-based institution. With transformational leadership and coherent management, we will build upon our proud heritage in pursuit of clear strategic objectives." (Ref 1)

The military environment is changing rapidly as geo-political conflicts, terrorist acts and other asymmetric threats have become the prime concern of defence planners. An expanded threat spectrum is part of the changing nature of military operations. The events of 11 September 2001 demonstrate that, with determination, covertness and a variety of weapons, "unconventional threats" can deliver massive blows to both military and civilian targets. Weapons proliferation and continuing advances in technology can be expected to worsen the situation.

> "Canada needs and benefits from combat-capable maritime, land and air forces able to fulfil a broad range of missions and tasks. While Canada faces no direct conventional military threat, the world is becoming increasingly complex and unpredictable. There remain direct and indirect threats to our national security for which a military response may be required, including drugs, organized crime, illegal immigration, terrorism and the uncertainty caused by the growing proliferation of missiles carrying weapons of mass destruction. As with our allies, Canadian defence planning is now based upon the capabilities Canada needs to protect and promote its interests and values in a responsive manner, rather than upon direct threats to our well being." (Ref 2)

Military planners must take into account the opportunities presented by new technologies to counter potential threats – both "large" and "small". The challenge is to stay ahead of potential adversaries in the exploitation of these new technologies. For example, Defence Strategy 2020 states that:

"Militarily, the battlespace of the future will be global in scope, ranging from the sea floor to space. The emerging cyber-space environment adds another dimension to the battlespace. Military operations will be conducted at an accelerated pace, requiring rapid co-ordination of political and military objectives and increasing dependence upon information. The portability, range, precision and lethality of weapons will continue to improve, while the effective life span of sensors and weapon systems will decrease due to the rapid pace of technological change. Many emerging threats such as cyber and bio-terrorism will tend to be asymmetric." (Ref 2)

Military Logistics

The Canadian Forces Logistics Branch Handbook (Ref 3) quotes the NATO Glossary of Terms and Definitions to provide the following definition of military logistics:

> "The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive, it is those aspects of military operations, which must deal with the following issues:
>
> a. The design, development, acquisition, storage, movement, distribution, maintenance, evacuation and disposal of materiel;
> b. The movement, evacuation and hospitalization of personnel;
> c. The acquisition or construction, maintenance, operation and disposition of facilities; and
> d. The acquisition or furnishing of services."

Ref 3 goes on to state that military logistics concentrates upon the words "materiel", "personnel", "facilities" and "services". It explains the above definition by providing the following list of functions that concern military logisticians:

a. Supply chain management, which includes but is not limited to: materiel acquisition, storage, distribution and disposal;
b. Transportation: materiel movement, distribution, personnel movement, and evacuation;
c. Facility services;
d. Financial services;
e. Financial management;
f. Food services, clinical nutrition, and nutrition education;
g. Personnel services including personnel movement and documentation;
h. Postal services;
i. Maintenance: materiel maintenance and facility maintenance; and
j. Engineering: materiel design, development, facility construction, and maintenance.

The above list makes it clear that logistics considerations form a major component of all military operations, from the planning stages through to actual operations.

Aim

This paper is a preliminary examination of the relationship between various new technologies and modern military logistics. The emphasis is placed on the strategic implications of incorporating new technologies on various aspects of military logistics in the CF.

Scope

Military logistics is a very broad field and the range of technologies that have potential application to military logistics is even broader. Although this paper discusses a number of logistics-related issues, it does not purport to be a definitive analysis of the subject. It is not possible to discuss all technologies that may have logistics applications in this document.

Section II of this paper presents an overview of factors that affect military logistics. These include defence strategy as well as geo-political and socio-economic issues. Section III describes a spectrum of leading-edge technologies making use of the framework developed for the Defence Research and Development Canada (DRDC) Technology Investment Strategy (TIS). Some potential relationships between these technologies and military logistics are highlighted. Section IV is a brief discussion of the risks and opportunities contained in these new relationships. Also, several recommendations are made for future cooperation between the logistics and technology communities within DND. Finally, Section V contains some concluding remarks on the subject.

The Context for Military Logistics

Defence Strategy

The way ahead for Canadian Defence in the 21st Century is contained in Defence Strategy 2020.

> "At its core, the strategy is to position the force structure of the CF to provide Canada with modern, task-tailored, and globally deployable combat-capable forces that can respond quickly to crises at home and abroad, in joint or combined operations. The force structure must be viable, achievable and affordable." (Ref 2)

Critical attributes of this strategy are given in Strategy 2020 as follows:

a. Modernization;
b. Deployability;
c. Inter-operability;
d. Force Structure;
e. Domestic capability;
f. Jointness;
g. Capital Program;
h. Command and Control;
i. Engage Canadians;
j. Human Resources; and
k. Proactivity.

The list above contains many foci for military logistics. For example, the requirements for global deployability, long-term sustainment and joint operations with allies all require considerable logistic planning and coordination.

Planning Levels

The Canadian Forces Logistics Branch Handbook discusses three levels associated with Logistics Planning - Strategic, Operational and Theatre.

Strategic planning is the level of planning that addresses national objectives and the use of the various elements of national power, of which military power is one, to achieve these objectives. Key strategic considerations include determination of the most suitable force structure to meet such high level objectives and the assignment of resources within that force structure. Resources include personnel, equipment and infrastructure and logistics considerations are heavily involved in all such deliberations.

Operational planning is the level at which major operations are planned, conducted and sustained to accomplish the assigned strategic objectives within the assigned areas of

operations. From the logistics perspective, activities at this level ensure the logistical and administrative support of tactical forces. Planning at the national level can be characterized as "single" involving only one environmental command, "joint" involving more than one environment or "combined" involving more than one nation.

Tactical planning is the level of planning that deals with the basic functional employment of forces and weapons systems to defeat enemy forces or accomplish other strategic objectives.

Logistics "Sub-Systems"

In the context of the Land Forces, Ref 4 states that the Canadian Forces core sustainment capabilities will continue to be based on four systems for the foreseeable future:

a. Replenishment System;
b. Land Equipment Management System;
c. Personnel Support Services; and
d. Health Services System.

These logistics "sub-systems" apply to Maritime and Air Forces as well. The emphasis on Joint and Combined operations may blur these distinctions to some degree.

Canadian Joint Task List

The Canadian Joint Task List (CJTL) establishes a framework for describing and relating the types of capabilities that may be required by the CF. (Ref 5) The CJTL has eight major capability areas: Command; Information and Intelligence; Conduct Operations; Mobility; Protect Forces; Sustain Forces; Generate Forces; and Corporate Strategy and Policy. The CJTL is also hierarchical in nature with four levels of joint tasks, i.e. military strategic, operational (domestic), operational (international) and tactical.

Table 1 is the current DND policy with respect to the level of capability that the CF seeks to achieve in the various capability areas in the CJTL. The boxes marked as 'H' are those where the CF seeks to have a "high" degree of capability. Those marked as 'M' indicate a "medium" or "moderate" level of capability is considered acceptable, either because the CF cannot achieve a high degree of capability in this area of military operations on its own because of the challenge and complexity, or because the CF has assessed that the risks associated with only achieving moderate capability in that area are reasonable in the context of limited resources. An 'L' indicates that the CF seeks only a "low" degree of capability in that area, with a similar rationale as to the limited expectations in that area made as for 'M'. (The assessments of capability in Ref 5 are derived from policy as laid down in official documents, and from the Concept of Operations developed by the CF to achieve Government goals.)

Table I – Canadian Forces Capability Areas

LEVEL	COMMAND AND CONTROL		OPERATIONS			SUSTAIN	GENERATE	CORP. POLITY & STRATEGY
	Command	*Info & Intel*	*Conduct*	*Mobility*	*Protect*			
Military Strategic	H	H	L	H	L	L	M	H
Operational (Domestic)	H	H	M	M	M	M	M	M
Operational (International)	M	M	L	L	L	M	L	M
Tactical	M	M	M	M	M	M	M	H

The major focus of logistics planning for the CF is in the "Sustain" capability above although there are some logistics issues associated with the other capability areas as well. For example, transportation of consumables such as fuel and ammunition are required for training exercises that fall under the "Generate" capability. Under "Sustain", the CF requires "medium" capability levels at both operational levels as well as at the tactical level.

Geo-political Context for Logistics Planning

The CF must be cognizant of the geo-political realities that largely define where they will have to operate, whom they may face and what they will be asked to accomplish. For example, Defence Strategy 2020 states that the CF must:

> "maintain a relevant force structure that is inter-operable at the component and contingent headquarters level with Canada's allies, globally deployable and affordable over time." (Ref 2)

Such a policy has immediate logistics implications for the replenishment, equipment management, personnel support and health services "sub-systems" of military logistics.

Defence Strategy 2020 provides further guidance in the following view of the future:

> "Geo-politically, the United States will in all likelihood remain the dominant global power. Ethnic unrest, religious extremism and resource disputes will likely remain the main sources of conflict, but environmental degradation and the threat to the nation-state by globalization may arise as new sources. Non-

state actors such as drug cartels, non-governmental organizations and global corporations may become more important. Disparities between the developed and developing nations will remain. Advanced military technology, including not only weapons of mass destruction and their delivery systems, but also many of the systems emerging today will have proliferated widely among states and also to dangerous non-state actors." (Ref 2)

National and international military commitments directly affect logistics plans as support for operations must be provided with due consideration of climate, distance, remote equipment support, emergency medical services, local infrastructure and support, logistics command and control, enhanced risk to facilities, etc. This requirement was made Government Policy in the 1994 White Paper on National Defence (Ref 6), which not only placed emphasis on the defence of Canada and North America but also renewed Canada's commitment to participate in the military dimension of international security affairs as an active participant in NATO and the UN.

For example, transportation plays a large part in any logistics operation, ranging from relatively simple deployments of small numbers of personnel with little equipment to sustainment issues affecting large units over considerable distances. Even domestic activities (e.g. training and disaster relief) can be challenging, as Canada is a large and rugged nation with weather patterns that are often extreme. Canada shares a long border with a friendly neighbour; so international conflicts can be expected to be far from home bases. Also, as oceans surround Canada on three sides, movement of personnel and supplies must be accomplished by ship or aircraft – and these resources are in short supply. Logisticians must take these constraints into account when planning for sustainment, equipment support and personnel services in military operations. As well, operations and logistics planners develop equipment requirements (e.g. modern sea and air lift systems) that are derived from both Canadian defence policy as well as Canada's geographic situation.

Economic Context

There may be reduced concern for cost when a nation is at war, but in the context of peacekeeping/peace support operations, limited deployments under international auspices, asymmetric threats, etc., there remains a requirement to achieve policy objectives with due regard to economic constraints. Noting that government defence expenditures over the past decade have been declining in real terms (in the face of economic priorities elsewhere and as the world endures an economic downturn), fiscal restraint can be expected to be a continuing theme for Defence planners.

Clearly, new technologies that simultaneously lower cost and increase effectiveness/efficiency will be most welcome, while those that increase operating costs may not be viable unless an overriding operational benefit can be demonstrated. Economic aspects of technologies proposed for implementation in the CF can be expected to remain a prime concern.

Demographic Factors

The demographics of the population in Canada are changing. In the past, recruits into the CF (and in particular Non-Commissioned Members, NCMs) have tended to come from Anglophone and Francophone rural areas, have secondary school education (perhaps incomplete) and be males in the 17-24 age range. However, the population of Canada is becoming more urban-based, multi-cultural and better educated. Many immigrants to Canada have arrived from countries where hostile attitudes towards military recruitment are prevalent. Also, demographic projections indicate that there will be fewer Canadians in the age range that classically forms the CF target "recruitable population". These trends may make it difficult to recruit – particularly into the NCM ranks.

The implications of these demographic trends for future military operations may be substantial. The CF may be forced to adopt smaller unit and crew sizes and make maximum use of technology to maintain operational effectiveness. This will affect a wide variety of operational concepts and in turn affect the logistic requirements to support these new concepts. For example, smaller warship crew size might reduce food requirements at the same time that requirements for equipment spares increase, i.e. to offset loss of onboard maintenance personnel. On the plus side, a "better educated" recruit population may be well placed to work more effortlessly with new technologies as they are introduced to the CF.

Relationship Between Technologies and Logistics

The Technology Investment Strategy

In 1999, DRDC published a Technology Investment Strategy (TIS) (Ref 7). The objective of this strategy is to ensure that the CF of the future remains technologically prepared and relevant. It was developed in response to the projected set of new capabilities that the CF and DND will need in 2010 and beyond. In particular, the TIS lists the following Outcomes as priorities for new defence capabilities in the future:

a. Timely, accurate asymmetric threat assessment and effective countermeasures;
b. Deployed covert, sensor systems with wide area coverage and adaptable resolution;
c. Rapid, reliable automated target identification, tracking and engagement of stealth targets;
d. Information and knowledge management for decision making in a complex environment;
e. Robust, survivable and covert systems for the 2020 warfighting environment;
f. Protection for the warfighter;
g. Lethality matched to mission - wide range of potential weapons effects;
h. Adaptable operator tailored systems;
i. Rapid technology development and insertion; and
j. Re-configurable simulators for training of individuals and teams mission rehearsal and acquisition.

Clearly the above list represents a wide range of capabilities that include military logistics and the support of operations. For example, command and control issues such as timely and accurate threat assessments contribute to effective logistics planning and operations. Benefits include "just in time" delivery for ammunition, fuel, repair and overhaul, etc. Also there are logistics applications for sustainability through the employment of improved materials, power sources, protective clothing, medical supplies etc. New munitions have potential logistics applications by improving transportation and the maintenance/handling of weapons. As well, simulators have a variety of potential logistics applications – primarily in equipment acquisition, training and support.

Technology Opportunities

The TIS lists a number of "opportunities" for the development of new and improved capabilities for the CF in the future and many of these have direct or indirect logistics applications:

a. Autonomous Intelligent Systems (AIS);
b. Human-Systems Integration (HSI);
c. Knowledge Management (KM);
d. Artificial Intelligence (AI);
e. Human Performance and Capability;
f. Modelling and Simulation;
g. Software Engineering;
h. Wideband Communications and Networks;
i. Embedded Sensors;
j. Nanotechnology / Miniaturization;
k. Smart Materials;
l. Structural Materials;
m. Novel Energetic Materials;
n. Biomolecular Engineering;
o. Massive Computing;
p. Laser Technology;
q. Power Sources; and
r. Microelectronic Materials and Components.

Some technologies such as AIS may contribute directly to crew/unit size reductions and thereby also reduce sustainability requirements. However, reliability and maintainability may be issues of concern. Embedded sensors have the capability to radically improve ammunition and spares management in the same way that commercial "checkout counters" automatically re-order stock for items that are being purchased or drawn down. Other technologies such as those that fall under the headings of communications, KM and HSI may affect logistic support indirectly through their contributions to enhanced Command and Control. (Effective Command and Control of logistics resources can be as important for military success in the long run as are weapons and sensors.)

Modelling and simulation techniques have strong logistics applications by contributing to improved training techniques, streamlined equipment acquisition and better logistics operations - perhaps with reduced resource expenditures. Models can be applied to optimize resource allocation "on the fly" and produce improved decision-support for logistics plans and operations. Software engineering and massive computing enable improved fidelity and speed of logistics planning models/algorithms.

Emerging materials may reduce maintenance, transportation, power and supply requirements. There are logistics and operational benefits of longer shelf life and better performance in extremes of heat, cold and humidity. Improved munitions lethality may also reduce weapons loads and lighten the sustainment burden. For example, laser weapon systems will not require

"bullets" to be transported from rear echelons. At the other extreme of logistics applications for lasers, bar-code systems will be dependent on rugged laser systems in the field. In general, the employment of Microelectronic Materials and Components as well as Nanotechnology contributes to reduced weight and space in all types of military equipment, thereby reducing sustainment requirements at the same time that reliability and maintainability are improved. Finally, improved power sources offer considerable benefits to the logistics planner, reducing the supply burden for fuel at the same time as improving the efficiency and effectiveness of all vehicles – including those that supply fuel to others.

DRDC R&D Activities

The TIS provides a set of guiding principles in order to define future R&D Activities:

a. Develop core competencies;
b. Exploit technology opportunities;
c. Respond to "Outcomes";
d. Focus on world class niche R&D areas;
e. Espouse quality rather than quantity;
f. Be forward looking;
g. Ensure strategic defence relevance;
h. Avoid fragmentation – integrate; and
i. The sum of niche R&D areas defines all Defence R&D.

Based on these guiding principles, 21 R&D Activities were identified for DRDC. Although the TIS is being updated in 2002, the 1999 activities list remains relevant to this discussion:

a. Autonomous Intelligent Systems;
b. Chemical / Biological / Radiological Threat Assessment & Detection;
c. Command and Control Information Systems;
d. Communications;
e. Electro-Optic Warfare;
f. Emerging Materials and Bio-Molecular Technologies;
g. Human Factors Engineering and Decision Support;
h. Information and Knowledge Management;
i. Multi-Environment Life Support Technologies;
j. Network Information Warfare;
k. Operational Medicine;
l. Platform Performance and Life Cycle Management;
m. Precision Weapons;
n. Psychological Performance;
o. Radio Frequency Electronic Warfare;
p. Sensing (Air & Surface);
q. Sensing (Underwater);
r. Signature Management;
s. Simulation and Modelling for Acquisition, Rehearsal, Requirements and Training (SMARRT);
t. Space Systems; and
u. Weapons Effects.

It should be noted that the 21 R&D Activities do not cover all the technologies that might contribute to improved CF capabilities in the future because it was assessed that some areas would be better addressed through academic or industrial R&D, co-operative work with allies, etc. - leaving DRDC to focus on world class niche R&D areas.

The Revolution in Military Affairs

The Revolution in Military Affairs (RMA) represents a major change in the way military operations (and hence support functions) will be planned and conducted in the future. For example, significant improvements are expected in connectivity for both operational and support echelons. With respect to logistics, this should translate into better service levels for maintenance/repair and for delivery of consumables. Ammunition, fuel and food usage rates should be part of the improved information exchange so that logisticians and operators become better connected to satisfy requirements as they arise (with perhaps better anticipation of requirements as well).

One specific instance of new technology having multiple ramifications on logistics planning is the "smart bullet effect". That is, when weapon effectiveness improves, transportation requirements (weight, volume, security, etc.) may be reduced. If one round or missile can do the same job as was previously accomplished by say 10 or 100, then there are clear logistics advantages - not to mention the obvious operational benefits. Therefore, improved munitions can reduce stress on the supply and transportation systems. Furthermore, new technologies that produce insensitive munitions reduce risk to logistics personnel and vehicles and may also reduce overhead for handling and safety gear. (There may be cost, personnel, equipment and timeliness benefits in reducing demand for inspection, testing and proofing of munitions and other energetic materials.)

Another example of technology affecting logistic requirements is protective clothing. Requirements for re-supply items can be expected to decline as improvements are made to the durability and effectiveness of combat protective equipment as well as decontamination gear and clothing. The net effect of such improved technologies may be to lower sustainment requirements in the field. Improved coatings for clothing and equipment may also reduce wear-out and lengthen operational lifetimes for re-supply items.

Although somewhat speculative, this section of the paper proposes that relationships can be established between new technology opportunities and certain logistics functions.

Supply Chain Management

Supply chain management is a complex field that incorporates many aspects of "Information and Knowledge Management" as well as "Command and Control Information Systems" in order to satisfy operational demands. At warehouse, base, ship and mobile logistics facilities, techniques associated with "Human Factors Engineering and Decision Support" technologies are used to improve service levels. Also, "Communications" technologies contribute to logistics support functions at the tactical and operational levels. "Network Information Warfare" will be a factor in keeping logistics functions available to deployed units and

denying such support to hostile forces. Also, "SMARRT" can play a role in the development and testing of new logistics concepts and facilities management.

Transportation (Personnel and Material Movement)

A number of technologies listed in the TIS will affect transportation systems. "Autonomous Intelligent Systems" may be involved in not only the sensor and weapon delivery side of military operations but also in the supporting role (e.g. transportation of materials in response to the demands generated by units and crews in the field). Automated systems may themselves make use of embedded sensors to improve their own maintenance support. "Command and Control Information Systems", "Communications", "Information and Knowledge Management" and "Network Information Warfare" all affect the operations of the transportation and re-supply systems, allowing these to remain viable in the face of disruption and responsive to operational needs. "Platform Performance and Life Cycle Management" and "Emerging Materials and "Bio-Molecular Technologies" can improve sustainment platform performance and reduce weight and volume requirements to support operations. The technologies developed in "Human Factors Engineering and Decision Support", "Multi-Environment Life Support Technologies" and "Operational Medicine" affect various aspects of the transportation and evacuation of personnel to and from deployed locations. "SMARRT" will play a role in the development and testing of transportation concepts.

Faster, more fuel-efficient and well-focused transportation systems all contribute to improved operational effectiveness. The requirement is for food, fuel, ammunition, spare parts, etc. to arrive in a timely fashion with minimum wastage and administrative overhead. Relevant new technologies would include better power sources as well as better mechanical and electrical components for transportation equipment.

Personnel Support Services

New technologies in "Operational Medicine" will increase the effectiveness of routine and emergency medical support to deployed CF members, as will "Multi-Environment Life Support Technologies". Improved personnel support (e.g. textiles, coatings) can be expected from "Emerging Materials and Bio-Molecular Technologies". "Chemical / Biological / Radiological Threat Assessment & Detection" will protect deployed CF personnel as well as logistics and operational facilities in the face of a CBR threat – both in domestic locations and on international deployments. "Command and Control Information Systems" and "Information and Knowledge Management" technologies will contribute to improving the operations of modern financial and personnel support services. "Human Factors Engineering and Decision Support" will improve the delivery of these services and avoid information overload.

If unit personnel reductions can be accomplished, then savings would accrue in logistics support. Smaller ship complements would reduce requirements for food and water as well as medical and administrative support. The same applies if Land Force units are able to maintain operational effectiveness with smaller unit sizes. Also, improvements to equipment reliability and maintainability would lower requirements for support personnel in or near "front line units".

Maintenance and Engineering

A host of new technologies will affect maintenance and engineering for the CF. Almost all TIS activities that relate to weapons, sensors and platforms will have some relationship to the evolution of maintenance concepts and engineering support for the CF. New equipment and systems will require new design, development, construction and maintenance facilities and procedures. Of particular relevance are the technologies being developed under the following TIS Activities: "Autonomous Intelligent Systems"; "Platform Performance and Life Cycle Management"; "Emerging Materials and Bio-Molecular Technologies"; and "Signature Management" as well as those activities directly related to the development of new weapons and sensors.

In the future, embedded sensors in mechanical and electronic systems can be expected to incorporate self-testing features that diagnose mechanical and electrical faults as they arise. Improvements to connectivity could allow for the immediate transmission of problems to repair sites or logistics "nodes". This would result in shorter turnaround time, improved operational availability and better inventory control. Improved communications systems (i.e. lighter, smaller, lower power requirements, jamming resistance, etc.) would be enabling technologies for this to occur. Therefore, developments in power sources, nanotechnology, computer hardware and software would all affect logistics services.

Software and database maintenance and engineering will also provide a challenge to the CF, making use of leading edge technologies being developed under TIS Activities "Command and Control Information Systems", "Communications", "SMARRT" and "Information and Knowledge Management". In consideration of the CBR threat to domestic and deployed maintenance facilities, the TIS Activity "Chemical / Biological / Radiological Threat Assessment & Detection" is also relevant.

Discussion

New Technologies

As technologies are developed, military planners can be expected to examine these initiatives and take advantage of opportunities that may arise to improve military efficiency and effectiveness. Some of these technologies may improve integration, interoperability, reliability and the speed of information flow. Planning, training and execution of operations may all be affected by technological change and hence logistics planners must also take technology issues into account. Furthermore, technological change may provide opportunities to reduce costs and increase the military effectiveness of the CF. The relationship between technological developments and logistics capabilities requires further examination.

In a broad sense, new technologies that military logisticians require can be classified into two areas. The first area is related to "what" issues such as improvements to hardware (and software) that have material impact on logistics functionality. For example, improved munitions, training simulators, power sources, protective clothing, etc. These technologies have the potential to reduce demand for consumables, improve logistics equipment and provide better support for personnel. The second broad technology area is related to "how" issues such as the optimization of logistics procedures, information and knowledge management, logistics war gaming, operational research models, simulations, etc. Such techniques offer considerable scope for improvements and efficiencies in logistics operations – ranging from supply system operations to equipment and personnel support in "battlefield conditions".

Risks

Could logistics functions become "too dependent" on particular new technologies? This risk should not be ignored. For example, complex, automated logistics support systems like those in any other communications network might be vulnerable to disruption, spoofing or interception. This could cause erroneous demands for resupply, medical services, transportation, etc. when not required, needed elsewhere, etc. Therefore, an automated logistics system must be protected from disruption just like any other C2 system.

Modern materials, weapons and sensors often require specialized support services (e.g. maintenance and handling) that may not be available or be in short supply at distant (and perhaps hostile) locations. For example, a new CBR detector may have superior performance but not operate in very high or low temperature environments (thereby restricting employment with the CF).

Reduced crew size on ships and in other units may be positive moves with respect to logistics effectiveness. However, smaller complements may mean an increase in ship vulnerability to fire and combat damage. Damage control, boarding parties, replenishment at sea, etc. are all labour intensive and may cause problems during operational deployments. Crew fatigue may

become the limiting factor. Similarly, the arrival of long haul air transportation and surveillance platforms may increase the risk for operator fatigue.

In dealing with asymmetric threats, the logistics vulnerability of modern forces becomes a prime concern. Although threat levels may be ill-defined to our forces, concentration of "friendly" logistics assets such as weapons caches, fuel dumps, C2 nodes, etc. are highly desirable targets for enemy/terrorist attack – giving the other side considerable economy and efficiency for their "operations".

Modernization of Command, Control and Communications may be problematic from the point of view of interoperability - even when there are no hostile countermeasures. Certainly, there is some concern that the CF may not be able to afford improved US Command and Control systems that potentially leave allies "out of the loop" – both operationally and logistically.

Human Resource (HR) Issues

There are HR risks associated with the adoption of new technologies. Manpower reductions on ships and in other units have already been mentioned in this paper. The move towards contracting out certain logistics functions (e.g. Alternate Service Delivery, ASD) contributes to the "demilitarization" of certain functions that may be required in the future. Civilian doctors and equipment maintainers cannot be expected to work in battlefield conditions, for example. Reductions and amalgamations of logistics military occupations (RMS Clerks, Cooks, Postal Clerks, Supply Technicians, Ammunition Technicians, Traffic Technicians, MSE Operators as well as Logistics officers) can have deleterious effects on careers, morale and retention in these occupations.

Cost Issues

Economic realities dictate that even the best technologies may not be accepted into the CF if the cost of acquisition is excessive. Furthermore, costs must be examined in the context of the full life cycle of the proposed technology as applied to CF equipment and operations. Although some technologies are relatively inexpensive to develop and apply, others represent substantial investments. Certainly, Canada will be unable to be a world leader in the development of all the technologies that might be of interest to the CF, but leveraging R&D efforts with allies and partners offers an attractive alternative.

Observations

At this point, there appears to be no single focus, lead organization or manager in DRDC with prime responsibility for technical issues that concern military logisticians. This compares with the matrix approach of Scientific Advisors, Science and Technology Directors in DRDC Headquarters, Laboratory Section Heads, Thrust Leaders, etc. who support Client Groups 1 through 5. Without a strong focus, there is ample opportunity for the logistics aspects of technology R&D "falling between the cracks". This difficulty is compounded if there are few advocates of logistics technology R&D in the CF client community.

The 21 Activities listed in the DRDC TIS represent niche areas of expertise and do not address all technologies relevant to military logistics. For example, improved power sources, lasers and nanotechnology all have possible logistics applications. Although some of these technologies may become available from commercial or academic sources, military requirements may be ignored. Furthermore, Allied military logistics R&D may not adequately reflect Canadian military requirements. Is a "Canadian solution" required?

Finally, a balance should be found between R&D on improved equipment, hardware and software ("what" issues) and R&D on "how" issues such as logistics war gaming, models, simulations, etc. Each has benefits for the logistics planner.

Recommendations

The following recommendations are made in consideration of the above:

a. CF logistics planners should become more familiar with the R&D activities and expertise within DRDC and DRDC staff should in turn become more familiar with CF logistics R&D requirements[1];
b. Clients for logistics technology R&D and DRDC managers should establish a more formal relationship to plan and execute R&D in the Canadian military logistics domain; and
c. Technologies that are not currently in the DRDC TIS but that have value to the military logistics community should be identified. As well, the means to acquire such technologies should be identified.

[1] A workshop that brings together interested parties from the logistics and R&D communities can start this process. J4 Log and DRDC staffs are planning to convene such a workshop in the near future.

Concluding Remarks

As military operations become more challenging and complex, logistics planners must deal with a wide spectrum of requirements to support these operations in the future. Geography, international commitments, economic constraints and national demographics will influence the nature of logistics support required by the CF.

New technologies offer a number of potential advantages to the CF with respect to efficiency and effectiveness. The DRDC Technology Investment Strategy describes a wide variety of technologies that may have application to the maintenance and improvement of logistics capabilities that the CF will need in the future. These range from supply chain management and transportation to personnel services and equipment maintenance.

Opportunities will exist to incorporate leading edge technologies into CF equipment systems, services and procedures. These can be expected to improve reliability, decrease personnel and equipment vulnerability and improve logistic service levels. However, there are risks associated with becoming too dependent on some technologies as the future threat becomes more capable and unpredictable. Therefore, the relationship between these new technologies and CF logistics capabilities requires careful examination.

References

1. "Vision Statement", Defence Planning Guidance 2001. Available from the website: http://www.vcds.dnd.ca/dgsp/dpg/dpg2001/chap2_e.asp

2. Defence Strategy 2020 is available at the following website: http://www.vcds.dnd.ca/cds/strategy2k/intro_e.asp

3. The Logistics Branch Handbook is available at the following website: http://www.dnd.ca/admmat/logbranch/handbook/Volume1/Vol1_e.htm

4. Beno, BGen(R) Ernest B. and Joly, Col(R) John D., **Sustainment Capabilities For The Army of the Future**, Directorate of Land Strategic Concepts (DLSC) Research Note 0001, dated March 2000.

5. The Canadian Joint Task List is described at the following website: http://www.vcds.dnd.ca/dgsp/dda/cjtl/intro_e.asp

6. The 1994 White Paper on National Defence is available at the following website: http://www.dnd.ca/eng/min/reports/94wpaper/white_paper_94.html

7. The DRDC Technology Investment Strategy is available at the following website: http://www.crad.dnd.ca/public/tis/tis_e.html

List of Abbreviations

AI	Artificial Intelligence
AIS	Autonomous Intelligent Systems
ASD	Alternate Service Delivery
C2	Command and Control
CBR	Chemical, Biological and Radiological
CF	Canadian Forces
CJTL	Canadian Joint Task List
DND	Department of National Defence
DRDC	Defence Research and Development Canada
HR	Human Resources
HSI	Human-Systems Integration
KM	Knowledge Management
MSE	Mobile Support Equipment
NATO	North Atlantic Treaty Organization
NCM	Non-Commissioned Member
R&D	Research and Development
RMA	Revolution in Military Affairs
RMS Clerk	Resource Management Support Clerk
SMARRT	Simulation and Modelling for Acquisition, Rehearsal, Requirements and Training
TIS	Technology Investment Strategy
UN	United Nations

DOCUMENT CONTROL DATA SHEET		
1a.PERFORMING AGENCY DRDC/DST Pol		2. SECURITY CLASSIFICATION Unclassified
1b.PUBLISHING AGENCY DRDC		
3. TITLE (U) New Technology Applications for Military Logistics		
4.AUTHORS Jesion. A.		
5.DATEOF PUBLICATION March 2002		6.NO.OF PAGES 20
7.DESCRIPTIVE NOTES		
8.SPONSORING/MONITORING/CONTRACTING/TASKING AGENCY		
9.ORIGINATORS DOCUMENT NUMBER Technical Memorandum 2002-002	10.CONTRACT,GRANT,THRUST AND/OR PROJECT NO. Thrust 20ab	11.OTHER DOCUMENT NOS.
12.DOCUMENT RELEASABILITY Unlimited distribution		
13.DOCUMENT ANNOUNCEMENT Unlimited		

14.ABSTRACT

(U) This paper is a preliminary examination of the relationship between various new technologies and modern military logistics. A brief overview of Canadian military logistics is given together with a list of important factors such as defence policy and geography that play a significant role in logistics planning. Making use of the framework developed for the Defence Research and Development Canada (DRDC) Technology Investment Strategy (TIS), a number of leading-edge technologies are listed and their potential relationships with military logistics are highlighted. Finally, a short discussion of the opportunities and risks contained in these relationships is presented.

15.KEYWORDS.DESCRIPTORS or IDENTIFIERS

(U) Research and Development, Military Logistics, Technology, Defence Policy, Logistics Planning